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EVIDENCE SUGGESTIVE OF THE OCCURRENCE OF
'INDIVIDUAL DICHROMATISM' IN
MEGASCOPS ASIO.

BY ARTHUR P. CHADBOURNE, M.D.

Plate I.

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ERRATA.

- Vol XIV, p. 35; 7 lines from bottom, for *continued* read *combined*.
p. 36; under figure in text, for *near A* read *near B*.
p. 36; 6 lines from bottom, for *fig. 1* read *fig. 2*.
p. 37; note 1, before *Feathers from Skins* omit *Cast-off*.
p. 38; Explanation of Fig. 1, for *No. 4396* read *No. 4397*.
p. 38; Explanation of Fig. 2, for *near B fig. 1* read *near A fig. 1*.
p. 38; last line, after *obj.* insert *2mm. oil imm.*
p. 39; next to last line, for *C fig. 3* read *C fig. 4*.

Arthur P. Chadbourne, M. D.

Apr. 26, 1894

193 Bracon St.

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CHADBOURNE on *Individual Dichromatism*.

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EVIDENCE SUGGESTIVE OF THE OCCURRENCE OF
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BY ARTHUR P. CHADBOURNE, M. D.¹

THE common Screech Owl and some of its varieties are typical examples of dichromatism, which may be defined as the occurrence of two distinct phases of color *in different individuals* of the same species, entirely independent of age, sex, or season. It is evident that "the occurrence of two distinct phases of color" *in the same individual*, if "independent of age, sex, or season," must constitute an *individual*, as distinct from the *specific* form of dichromatism. The following account of a pair of Screech Owls shows that 'individual dichromatism' probably occurs in this species, though it is doubtless infrequent, and possibly found only under artificial or even diseased conditions.

Two Screech Owls (*Megascops asio*), said to have been taken from the same brood late in the spring of 1894, were sent to me about Nov. 1, 1894. Both birds were in typical gray plumage, but a minute examination of the feathers was not made at the time, as the possibility of a change in phase had not been thought of, though, as an intermediate between the red and the gray plumage was wanted, it is safe to say that any reddish tint would have been noticed if present. The two Owls were in full autumn dress except for a few downy feathers near the so-called "ears."

The Owls were put in a large box cage, with the front of wire netting; and a hole at one side opened into a second box, thus making a dark retiring place, that was never used. Six times each week they were given all the raw beef or sheep's liver that they wanted; but the seventh day they fasted. Fresh water for drinking and bathing, and also gravel were put in the cage daily; while in addition dead guinea pigs, and occasionally live mice, were to be had in the 'animal room' at the Medical School, where

¹ Read at the meeting of the Nuttall Ornithological Club, March 4, 1895.

the cage had been placed. These 'tid-bits' were the cause of much trouble, and after the first trial I never put a mouse in the cage unless there was a second mouse for the other Owl, as a dangerous fight was sure to be the result. By day their sight was as keen as at dusk, but the birds were more restless after dark, though it was necessary to watch closely to prevent them from slipping out while the door of the cage was opened to give them daily food, and I doubt if a movement of any kind was often made that their sharp eyes did not notice. Like all 'Scops' they were quickly tamed, and quite gentle unless frightened. Twice I heard the tremulous '*whou-hou-hou-hou-hou*' note, each time just after dusk when all was quiet and when no gas was lighted. Spitting, and a scolding rattle when disturbed, were the only other sounds that they were heard to utter. The 'pellets' were unlike those found near the familiar 'owl-holes' and looked like uncooked sausage-meat minus the fat. No gravel was ever found in these castings, yet though more friable than those of the wild birds, they were always firm, well formed, and seemingly held together by a sticky coating that soon dried and looked like gelatine.

Toward the last of November, nearly three weeks after arrival, the larger, and, as it proved, the female Owl, grew more and more red-brown in tint, until there was little pure gray to be found. This was followed by a constantly increasing amount of tawny red; while simultaneously the brownish tinge spread over the upper parts and tail-feathers, and the dark cross bars on the breast seemed to fade. The difference was so marked as to be spoken of by five different persons, who had seen the birds at first. Meanwhile the smaller Owl remained unchanged, so far as could be seen, although in the same cage and apparently under the same conditions as the other.

From the first I searched the cage daily for cast-off feathers, as I wanted to know the number lost when the birds were not molting. During the three weeks and two days only twenty-four feathers were found; 15 of the 'first plumage', 3 tail-feathers and 6 mature feathers, or at least not those of the first plumage. The twelve or even twenty-four new feathers, which had doubtless replaced those lost, were evidently not the cause of the general alteration

in tint that could be seen in almost every feather of the female. On the other hand, it might perhaps be claimed that the total number of feathers composing the plumage had increased, and that the new phase was due to the freshly developed feathers mingling with the old that had been present from the first. The interest and importance of the change in tint of the female Owl was now realized and a thorough search for pin-feathers was made, but without success. Three of the feathers on the breast that seemed without a trace of red or brown in the ground color, were then marked with a pair of scissors to see if they would remain unchanged, but within the next week I found all three feathers on the floor of the cage; two feathers around which I tied a bit of hair, were also cast off or pulled out; and the same result followed with two feathers that were slightly marked with a solution of eosine and water; and also with two that were marked with bi-chromate of potassium. There seem^{ed} to be only one way left in which to settle the question as to whether the gray feathers actually changed their tint; so having first 'mesmerized' (?) the owl by laying her on her back and gently stroking her head until she was quiet, I carefully counted all the feathers having a dark median stripe, but without any red or brownish tinge in the ground color, beginning just below the whitish feathers of the throat and going as far as the under tail-coverts, and from the median line of the body to the unstreaked downy feathers under the wing; the result was forty gray feathers. Only three weeks later, on Dec. 21, I could not find more than nine feathers that were free from brownish tinge. It must, I think, be admitted (1) that an actual change from gray to red-brown took place in the individual feathers, and (2) that the red phase was not entirely, if at all, due to new feather growth in the present instance.

Until December 22, the diet of beef liver was continued, but was occasionally varied by beef kidney, the other conditions remaining as before. The larger Owl continued to approach more and more nearly the red-brown phase, and on Dec. 21 had the general tawny-brown effect seen in specimens that do not show the brilliant red, typical of extreme examples of this phase. Both birds seemed healthy and well; but the smaller Owl now also showed more or less signs of reddish-brown here and there, and some

feathers taken from the breast on Dec. 21, were markedly tawny toward the base. From Nov. 1 until Dec. 21, a total of fifty-nine feathers had been lost by the two birds, but from this number, forty-two must be deducted — (9 lost because of my effort to mark them, 4 tail-feathers, 15 feathers evidently of the younger plumage, and the remaining 14 lost in a fight between the Owls for the possession of a mouse). This leaves for each of the Owls a total loss of nine feathers during the change described above; yet on one of the birds, as we have seen, the majority of the feathers were characteristic of the red-brown phase.

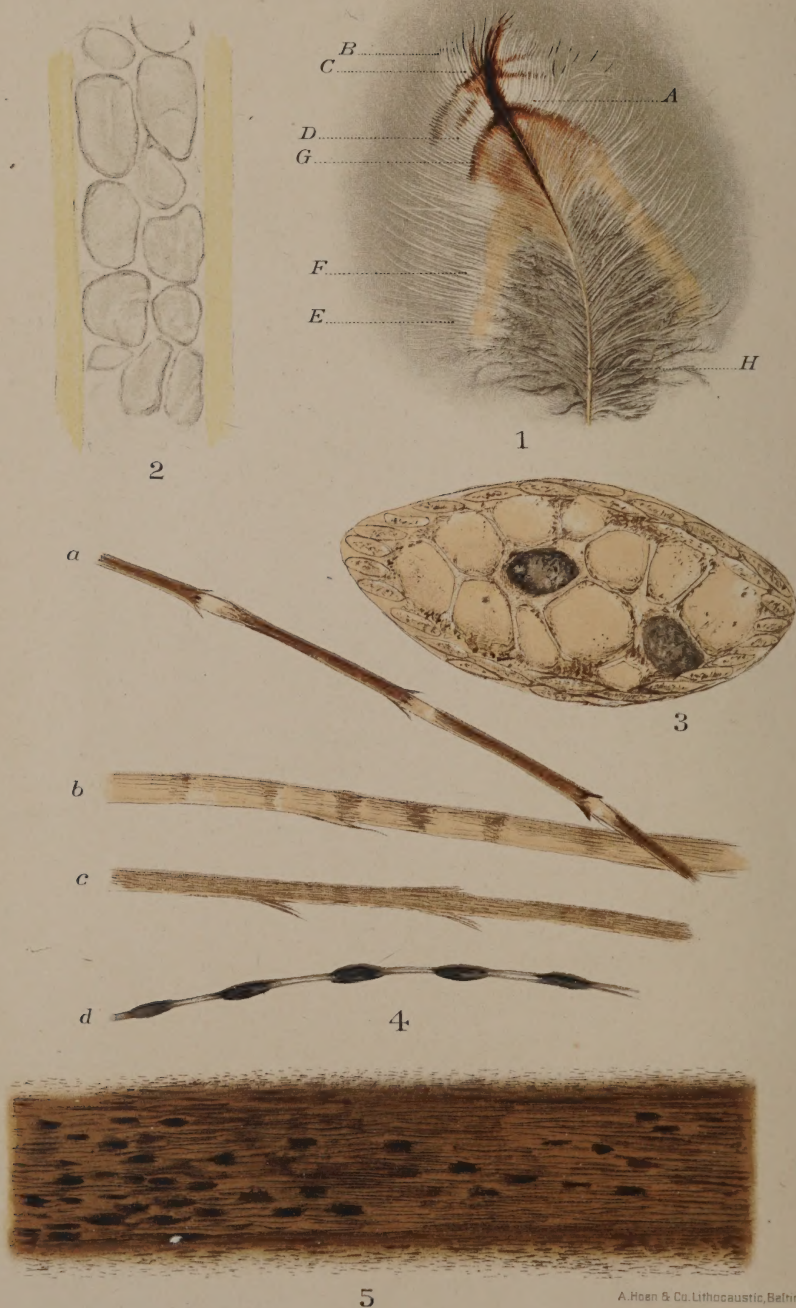
On Dec. 22, the Owls were sent to some Owl-loving friends in the country, where they could have space to fly about, and we hoped to have some young Owlets later. At this time the liver was stopped and they were fed upon raw meat. Every cast-off feather was carefully preserved and labelled, and I heard often of my pets, but especially about the color of the plumage. There seemed to be rather a loss, than an increase of the red-brown effect as time went on, and this was very evident, or at least I thought so, on Jan. 17, when I saw the surviving Owl, which was the larger red-brown female. The smaller and grayer bird had been killed and partly eaten by the other on Jan. 3.

On Jan. 19, the other Owl was found dead in her cage. She was sent to me and is now in my collection, No. 4397. A careful examination showed that the organs were all healthy macroscopically, but the bird was much emaciated, there being almost no fat about the kidneys and mesentery, and but little in the orbits. This was a marked contrast to the fatty degeneration from over-feeding which I believe is usual in captive Hawks and Owls. The condition of the bones of the skull proved that the bird was less than a year old.

This ends the history of my two pets, which I have intentionally given at considerable length. It seems certain that in the larger female Owl there was (1) *a change from the typical gray to the characteristic, though not extreme phase of red*; (2) *and that this was neither caused, nor accompanied by appreciable 'feather loss' (so-called 'moult')*; (3) *nor can it have been wholly, if at all, dependent upon new feather growth*; and (4) *it is also evident that there was a distinct change in the color of the individual feathers, which were apparently mature, as seen under the microscope.*

It cannot be said with absolute certainty that the reddish phase was "entirely independent of age, sex, or season," and hence an example of 'individual dichromatism'; but if due to such normal and universal laws as any of the above, the fact of a change of color in the individual could hardly have escaped the notice of ornithologists, while if caused by the ordinary conditions of captivity it must have been recognized long since. The evidence, therefore, seems to be *almost* conclusive that this Owl was an instance of what I have for convenience called '*individual dichromatism*'; and also that this condition is probably infrequent, and doubtless due to some unknown element, not common even in captivity.

(*To be concluded.*)



A. Hoen & Co. Lithocautic, Baltimore.

INDIVIDUAL DICHROMATISM
IN THE SCREECH OWL.

EVIDENCE SUGGESTIVE OF THE OCCURRENCE OF
'INDIVIDUAL DICHROMATISM' IN
MEGASCOPS ASIO.

BY ARTHUR P. CHADBOURNE, M. D.

*Plate I.**(Concluded from Vol. XIII, p. 325.)*

As to the cause of the altered color :— The exclusive diet of liver seems to be the only unusual feature in the conditions under which my two Owls lived, compared with other birds of prey in captivity ; or at least, it is the most noticeable one. We have already seen that the change in the female was first apparent after this food had been alone used for about three weeks, and also that the smaller Owl a little later showed signs of a similar change ; while almost an equal length of time after the liver had been discontinued, there seemed to be a gradual loss of the red tint. Was this chance, or is it a hint, as to the cause of the red brown color ? The liver is well-known to contain an extremely large amount of coloring matter, and to play an important part in the production of the majority of the different pigments of the organism, either directly or indirectly. Moreover, it is a fact that the color of the plumage can be altered by certain kinds of food — thus, some breeds of the Canary (the 'Yellow Norwich' among others), change from a pure yellow to a bright orange, if red pepper is daily mixed with their food ; and this too without any feather loss, as I have myself seen. Who can tell the effect of a continued diet of liver, until he has tried the experiment — on an Owl ?

The way in which the colors of feathers are produced can only be briefly mentioned here, but a few words on the subject may not be out of place. In general, feather-color is due (1) to pigmented matter of one, or of several colors ; (2) to the physical effect of the structure of the part on the light rays ; or (3) to both of the above combined. Pigment absorbs all kinds of light except that on which its color depends, thus in a brown feather the only unabsorbed light rays are those which produce the sensation of brown, and these alone reach the eye. Black results from the complete absorption, or deflection of all light rays ; while if none

of the spectral colors fail to reach the eye, the combination produces white. In addition, an almost endless variety of colors, shades and tints are caused by mixtures of different 'pigments,' much in the way we use different paints. The action of the structure and form of the colored parts is, on the other hand, purely physical; for example, the lateral branches, forming the vane, may have their surfaces so shaped, as to produce the effect of a multitude of small prisms, by which the different colored rays are made to diverge, only those of a certain color reaching the eye; perhaps, as believed by Gadow, slight movements bring different kinds of rays successively to the eye, and iridescence is the result.

Color-change in the individual feather, — or, in a broader sense, in the plumage as a whole, without adequate new feather-growth (*i. e.*, without a so-called 'moult'),¹ seems to have received little or no attention from ornithologists in this country during the past quarter of a century or more.² Yet about 1850, when the theory of "color-change without moult" was revived by Schlegel and Martin independently, German ornithological literature teemed with articles on this subject; and it had been proved even prior to this that the plumage might be completely altered in color without feather-loss or new feather-growth. And such color-change also seems to be normal, and probably recurs at regular intervals in certain individuals and conditions among various species. It has been shown in connection with the subject of the 'Spring Plumage of the Bobolink,'³ that feather-change and color-change are two distinct processes; but the point which concerns us at present is that *a change in the color of the feather, or even of the whole plumage, not only may, but has been proved to occur normally without increase of feather-loss.*

The color of my Owls was evidently due to pigmented matter, and was practically independent of the physical action of the structure of the part on the light rays. Morphologically, one

¹ The 'aptosochromatism' of Coues (*Cf.* Auk).

² The above was written in 1894, before the recent articles of Allen, Chapman, Stone and others had appeared.

³ 'The Spring Plumage of the Bobolink.' Auk, Vol. XIV, pp. —. [The publication of this paper is necessarily deferred till the April number.—EDD.]

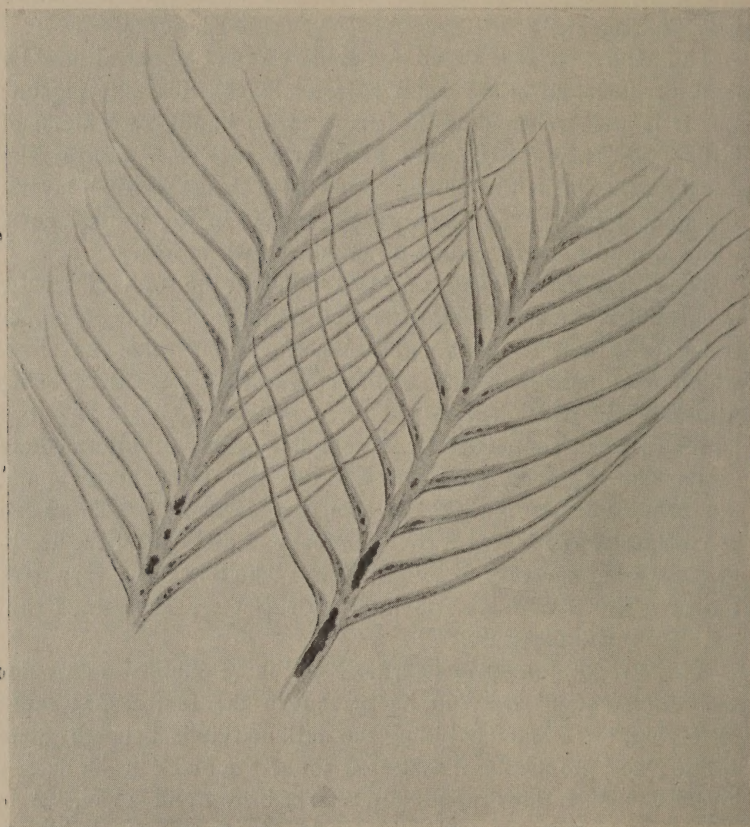
black, and at least two varieties of brownish coloring matter (so-called 'pigments'), were present, not only after the red-brown shade appeared in the plumage, but also in every feather of the gray type, except three of the 'first' and one from the mature gray plumage.

The *black pigmented matter* was made up of oblong-oval or elliptical granules, never of small rods, as in the domestic pigeon; but it is well-known that the shape varies in different kinds of birds. The amount of black granular matter was always relatively small, and it was chiefly confined to the deeper cell layers. Isolated spots of true black were frequent in the central cells, while around them there was often much dark brown.

The *brown pigmented material* was found in the form of a pale, nongranular, diffused stain, extending through all kinds of feather tissue; and also as brown granules, of various tints and sizes, which were usually in narrow lines or groups, instead of being generally distributed, like the nongranular stain. The two extremes were connected by a complete series of intermediate forms, showing every gradation between the dark chocolate and the ochraceous tint; while the size of the granules also varied considerably, and it was at times not easy to distinguish the homogeneous from the very finely granular. The black and very dark brown granules perhaps also intergrade, but on this point I cannot speak with certainty.

As the red phase developed, more and more red-brown granules and diffuse stain *seemed* to be present in the feathers, at times obscuring, or completely hiding the dark markings beneath (Plate I, fig. 1), or grouped and scattered about the black in the deeper layers, caused various shades and tints of brown and tawny. As a rule the seemingly black color proved to be the result of either a dense mass of dark brown granules, of the greater thickness of the darker portion of the specimen, or of both continued, plus an underlying area of true black in the deep tissues. The pure rufous and bright tawny portions had the coloring matter chiefly in the more superficial cell layers, and either little or no true black beneath; while the streaks and lines of brownish granules suggested the 'bast-fibre layer' of certain plants, and the tawny effect was heightened by the diffuse nongranular stain (Plate I, fig. 4, *b*

and *c*, fig. 5, and cut in text). In the white parts of the vane, the only color was a pale straw-yellow almost entirely limited to the outer (peripheral) cellular tissue, and probably caused by the



Two Barbs from near A., pl. I, fig. 1. Groups of dark colored cells are seen in some parts of the barbs. (Zeiss 16mm. apochromat. and No. 6 comp. oc.)

homogeneous stain (Plate I, fig. 1). The downy parts of the contour feathers had nodular enlargements at regular intervals, in which the coloring matter was usually collected (Plate I, fig. 4, *d*); in other specimens the nodes were almost colorless, and the internodes pigmented (Plate I, fig. 4, *a*). There seems to have been an absolute loss of black, as well as of the darkest brown granules.

during the progress of the change to the reddish phase, for markings were absent, not merely hidden by overlying color, which had been distinct in corresponding specimens of the gray phase.

Feathers from twenty-five specimens of *Megascops asio*¹ in the writer's collection, in all stages of plumage, were indistinguishable from those of the dichromatic female in corresponding dress, both the black and also the various shades of brownish pigmented matter being present in the large majority of specimens examined; but differing in relative amount and distribution.

¹ The material examined was as follows:

CAST-OFF FEATHERS FROM MY TWO OWLS.

First plumage		15 feathers.
Typical gray phase		9 "
Intermediate		56 "
During most marked stage of red-brown		10 "
Specimens from female after death of male		3 "
From skin of female		<u>127</u> "
Total		<u>220</u> "

CAST-OFF FEATHERS FROM SKINS OF M. ASIO.

2 specimens	first plumage, typical gray		91 feathers
1 "	" " " red		17 "
7 "	adult " " gray		114 "
9 "	" " intermediate		102 "
4 "	" " typical red		59 "

23 specimens 383 feathers

	Typical gray.	Intermediate.	Typical red.	Total.
Red-brown pig- m'ntd matter present	206=(95%)	148=(100%)	226=(100%)	580=(98%)
Red-brown ab- sent	13=(5%)	0=(9%)	0=(0%)	13=(2%)
Total feathers examined.	219=(36+%)	148=(25%)	226=(38%)	593

In short, so far as shown by the present material and methods of examination, the dichromatism of *Megascops asio*, both in the species and also in the individual, is a quantitative difference in the distribution and relative amounts of the same morphological varieties of pigmented matter; and there is probably also an absolute, as well as a relative difference in the amount of coloring material in the various phases.

Of the chemical and other relations between the pigmented matter, I shall say but little now. The usual qualitative tests and also the methods used by Krukenberg show that 'zoöruhin' (Krukenberg), and 'zoömelanin' were present in almost all the feathers. No other coloring matter was detected chemically; but differential staining brought out marked differences in the affinity of the various brown granules for certain dyes, and also in the color-reactions of the black and brown granules. The microspectroscope gave spectra agreeing with Krukenberg's outlines for 'zoöruhin.'

That the pigmented matter represents successive steps in a process of retrograde or destructive metamorphosis, seems not unlikely. The subject offers an attractive field for speculation, but one upon which we will not enter at present.

In conclusion, my two pets have, I think, fully proved (1) that a change from the gray to the red phase of plumage did, in this case, actually take place in the same Screech Owl (*M. asio*); (2) that the change in question was not accompanied by increased feather-loss or new feather-growth (i. e., no 'moulting' occurred); (3) that, so far as known the double phase was in no way due to age, sex or season; (4) and that almost beyond question it was an instance of true 'individual dichromatism.'

EXPLANATION OF PLATE.

Figure 1. Feather from skin of 'dichromatic' female *Megascops asio* (coll. A. P. C. No. 4396), showing the colors and parts illustrated in the following figures. Slightly enlarged. Drawn and colored from nature by W. H. Kaula.

Figure 2. Barb from white portion of feather near B fig. 1. (Zeiss 4mm. apochromat. obj. and No. 4 comp. ocular. Mounted dry.)

Figure 3. Transverse section through barb from near D fig. 1. Shows distribution of pigmented matter in the deep and superficial cells. (Zeiss apochromat. obj. and No. 4 comp. oc.—Celloidin and balsam.)

Figure 4. Variations in the barbules of the same feather.

A, from near fig. 1 E. — Pigmented matter chiefly in internodes.

B, from near fig. 1 F. — No true black coloring matter present.

C, from near fig. 1 G. Shows 'bast-fibre' arrangement of brown granules.

D, from near fig. 1 H. — Pigmented material almost lacking in internodes. (Zeiss 4mm. apochromat. obj. and comp. ocular No. 4.—Feather mounted dry.)

Fig. 5. A barbule much like that shown in C fig. 3, but more magnified. (Zeiss 4mm. apochromat obj. and No. 6 comp. ocular. Mounted dry.)

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